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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/943,222	08/31/2001	Hideki Hirayama	1794-0142P	8855

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EXAMINER
SONG, MATTHEW J

ART UNIT	PAPER NUMBER
1765	11

DATE MAILED: 06/20/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/943,222	HIRAYAMA ET AL.	
	Examiner	Art Unit	
	Matthew J Song	1765	

-- Th MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period f r Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08 April 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-27* is/are pending in the application.

4a) Of the above claim(s) *10-18* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-9 and 19-27* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

2. Claims 1-9 and 19-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nagahama et al (US 6,172,382).

Nagahama et al discloses a method of forming a nitride semiconductor light emitting and light receiving device, note entire reference, comprising a sapphire substrate **30** and a n-side cladding layer **14** composed of superlattices obtained by laminating one-hundred-twenty GaN layers doped with Si to $1x10^{19}/cm^3$, this reads on applicant's an impurity at a concentration exceeding its doping level, and one-hundred-twenty undoped $Al_{0.1}Ga_{0.9}N$ layers respectively by turns and a p-side cladding layer **19** composed of superlattices obtained by laminating GaN

layers doped with Mg to $1x10^{20}/cm^3$ and undoped $Al_{0.1}Ga_{0.9}N$ layers (Example 27, 33 and 35). Nagahama et al also discloses forming a p-side contact layer **20** of p-type GaN doped with Mg on the p-side cladding layer **19**. Nagahama et al also discloses the super lattice structure can nitride layers improved in crystallinity (col 2, ln 1-67) and n-impurities include IV-A,IV-B,VI-A and VI-B groups and p-impurities belong to I-A,I-B,II-A and II-B groups (col 4, ln 1-67). Nagahama et al also discloses the material of the substrate may include sapphire, SiC, or other material which are different from nitride semiconductors and are known for growing nitride semiconductors such as GaAs (col 55, ln 35-67).

Nagahama et al is silent to the superlattice of doped and an undoped nitride layers is a buffer. It is inherent to Nagahama et al's superlattice to function as a buffer because Nagahama et al discloses a superlattice with a similar structure, as applicant, used to form nitride layers with improved in crystallinity.

Nagahama et al teaches GaN layers doped with Mg to $1x10^{20}/cm^3$. Nagahama et al does not teach a plurality of first layers made of a nitride semiconductor containing an impurity at a concentration of $1.2x10^{20}$ cm^{-3} or more. The doping of nitride semiconductor layers with a dopant concentration of up to $10^{-21}/cm^3$ is well known in the art, note Shih et al (US 5,874,320), Nakamura et al (US 5,578,839) and Nikolaev et al (US 6,18,269) below. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Nagahama et al by optimizing the dopant concentration by conducting routine experimentation of a result effective variable (MPEP 2144.05). Furthermore, the selection of reaction parameters such as temperature and concentration is obvious (In re Aller 105 USPQ 233, 255 (CCPA 1955)).

Referring to claim 2, Nagahama et al does not teach an impurity concentration of the first layer is 10% or less. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Nagahama et al by optimizing the dopant concentration by conducting routine experimentation of a result effective variable (MPEP 2144.05). Furthermore, the selection of reaction parameters such as temperature and concentration is obvious (In re Aller 105 USPQ 233, 255 (CCPA 1955)).

Referring to claims 4-5, Nagahama et al discloses GaN and AlGaN, which are three-five semiconductors.

Referring to claims 6-9, Nagahama et al discloses SiC, sapphire and GaAs substrates.

Referring to claims 19-26, Nagahama et al discloses forming a p-type GaN doped with Mg on the superlattice to form a light emitting and light-receiving device, where GaN is a three-five semiconductor.

Referring to claim 27, Nagahama et al does not teach a threading dislocation density is substantially equal to $5x10^7$ cm^{-2}. This is inherent to Nagahama et al because Nagahama et al discloses a buffer layer with a similar structure of a superlattice of doped and undoped layers on a similar substrate with similar dopant concentrations, as applicant, note page 6, ln 18-25

3. Claims 1-9 and 19-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kiyoku et al (US 6,153,010).

Kiyoku et al discloses a method of forming a nitride semiconductor device, note entire reference, comprising a wafer, this reads on applicant's substrate, set in a MOVPE reaction vessel and forming a n-side cladding layer **213** having a superlattice structure by alternately

stacking a total of 100 20-angstrom thick first layers, each made of n-type $Al_{0.2}Ga_{0.8}N$ doped with Si at $5x10^{18}/cm^3$ and 20-angstrom thick second layers made of undoped GaN (Example 7). Kiyoku et al et al also discloses the threshold of a device can be decreased by performing modulated doping, where a p-die cladding layer **218** can be formed by alternately stacking first thin layers made of AlGaN doped with a Mg and second thin layers made of undoped GaN (col 23, ln 1-67). Kiyoku et al also discloses the substrate can be made of sapphire, SiC, GaAs or Si (col 7, ln 1-67). Kiyoku et al also discloses a buffer layer **81** has a distorted superlattice structure formed by alternately stacking an AlGaN doped with n-type impurity and undoped GaN layers, where a buffer with a superlattice structure can provide an n-side cladding layer having excellent crystallinity (col 20, ln 1-67).

Kiyoku et al teaches $Al_{0.2}Ga_{0.8}N$ doped with Si at $5x10^{18}/cm^3$. Kiyoku et al does not teach a plurality of first layers made of a nitride semiconductor containing an impurity at a concentration of $1.2x10^{20}$ cm^{-3} or more. The doping of nitride semiconductor layers with a dopant concentration of up to $10^{-21}/cm^3$ is well known in the art, note Shih et al (US 5,874,320), Nakamura et al (US 5,578,839) and Nikolaev et al (US 6,18,269) below. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Kiyoku et al by optimizing the dopant concentration by conducting routine experimentation of a result effective variable (MPEP 2144.05). Furthermore, the selection of reaction parameters such as temperature and concentration is obvious (In re Aller 105 USPQ 233, 255 (CCPA 1955)).

Referring to claim 2, Referring to claim 2, Kiyoku et al does not teach a impurity concentration of the first layer is 10% or less. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Kiyoku et al by optimizing the dopant

concentration by conducting routine experimentation of a result effective variable (MPEP 2144.05). Furthermore, the selection of reaction parameters such as temperature and concentration is obvious (In re Aller 105 USPQ 233, 255 (CCPA 1955)).

Referring to claims 4-5, Kiyoku et al discloses GaN and AlGaN, which are III-V semiconductors.

Referring to claims 6-9, Kiyoku et al discloses sapphire, Si, SiC and GaAs.

Referring to claims 19-26, Kiyoku et al discloses forming a Light emitting diode on buffer layer **81** (Fig 8A and col 20, ln 1-67).

Referring to claim 27, Kiyoku et al does not teach a threading dislocation density is substantially equal to $5x10^7$ cm^{-2}. This is inherent to Kiyoku et al because Kiyoku et al discloses a buffer layer with a similar structure of a superlattice of doped and undoped layers on a similar substrate with similar dopant concentrations, as applicant, note page 6, ln 18-25.

Response to Arguments

4. Applicant's arguments with respect to claims 1-9 and 19-27 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

5. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Nakamura et al (US 5,578,839) teaches dopant concentration affects the relative light intensity (Fig 9-10) and an InGaN layer with a dopant concentration within a range of about $10^{17}/cm^3$ to $1x10^{22}/cm^3$ (col 7, ln 30-40).

Nikolaev et al (US 6,218,269) teaches an III-V nitride semiconductor layer with an acceptor concentration in a range between 10^{17} cm^{-3} and about 10^{21} cm^{-3} (col 4, ln 20-35).

Shih et al (US 5,874,320) teaches a gallium nitride is doped with magnesium to form a P-type GaN until its concentration is on the order of 10^{20}~10^{21} cm^{-3} (col 2, ln 35-50).

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

MJS
June 16, 2003

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SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700